P A R T   III

SANITARY SEWER SYSTEM - BASIS OF DESIGN

CHAPTER 1S - GENERAL INFORMATION

The Scope of this Chapter is to put forth a basis for the design of proposed changes and future construction in the sanitary sewer system. It must be pointed out again that the Town of Saratoga is an impacted Town, undergoing rapid changes and increased growth potential. However, since 1976, the Town has put restrictions on building permits for new construction as the sewer system as well as the water supply system is inadequate.

The Chapter covers basis for the design of collection,treatment, and disposal facilities.

CHAPTER 2S. - SANITARY SEWER SYSTEM DESIGN DATA

Although the scope of this Chapter must be limited to only the major areas of the sewerage system, it is intended to serve as an aid to future, more detailed study, and design.

Sewage Flow Rates

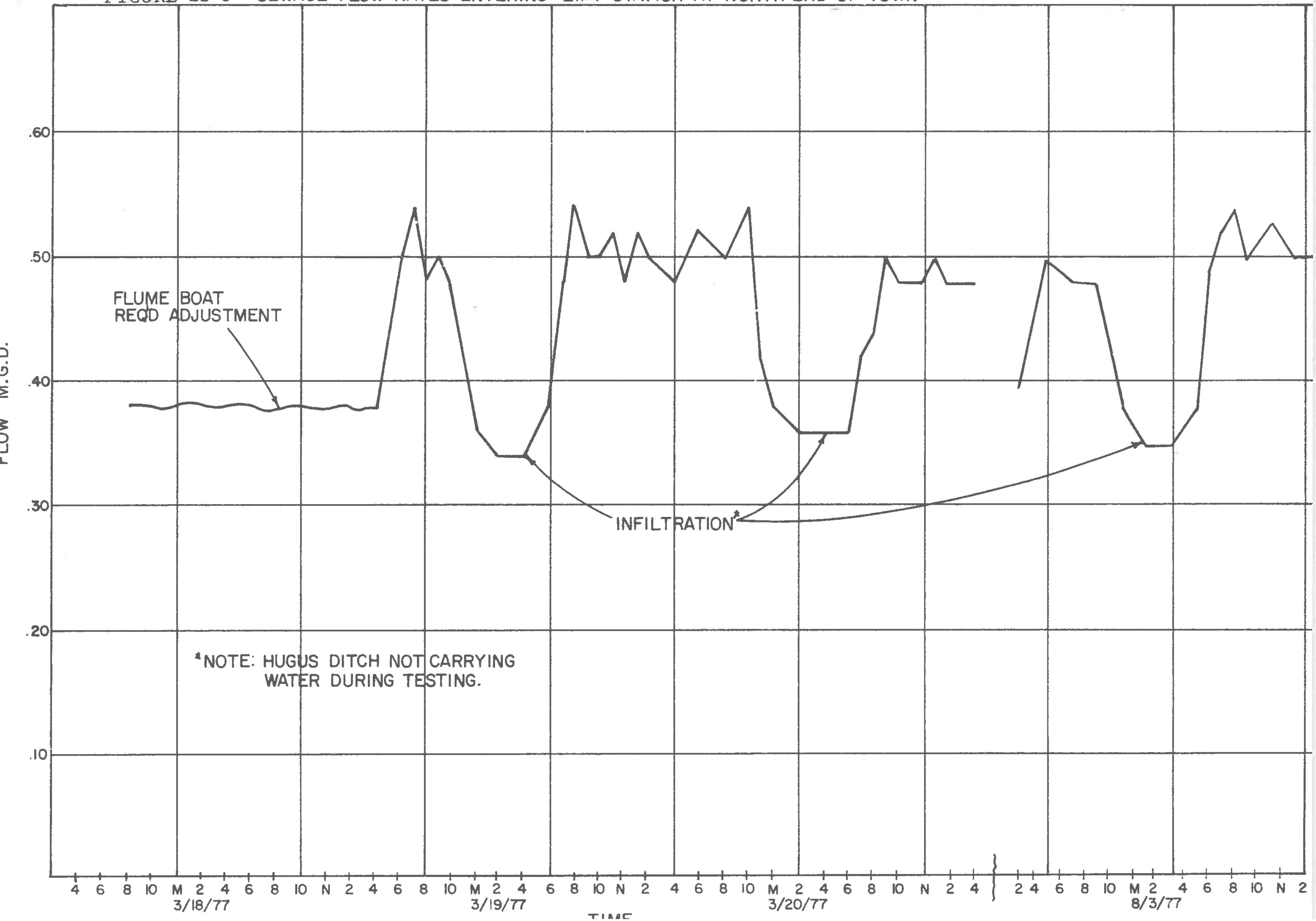
Determination of the quantity of sewage to be removed from a community is fundamental in the design of collection, treatment, and sewage disposal facilities. As with the water treatment system no population prediction has been attempted for the waste treatment system. The system will simply be designed to adequately collect wastewater flows from all areas and carry them to treatment and disposal.

No flow rates exist for the existing system. However, sewage flow rates are usually correlated with water consumption rates. Water consumption for the Town of Saratoga has been estimated at about 225 g.p.d.p.c. as discussed previously. The proportion of municipal water supply reaching the sewer system neglecting infiltration is usually found to be 60-80% of the water used, when no records exist. The factor used for peak flows is 1.8 to 2.0 times the average flow. Therefor average flows for Saratoga have been assumed to be 150 g.p.c.p.d. and 300 g.p.c.p.d for the peak flow rate.

Ground Water Infiltration

The serious problem in the Saratoga sewer system is ground water infiltration, most particularly in those lower areas of Town below the Hugus-Mullison Ditch. The infiltration in Saratoga accounts for as much as twice the normal sewage volume flow during the spring and summer months. W.E.A.I. measured flows in the Spring of 1977, see Figure 2S-1, and found infiltration rates of 0.50 - .6 C.F.S. or a population equivalent of about 2300. The infiltration is a serious problem and will be examined in more detail in a later Chapter. All sewer designs proposed in the following Chapter will be designed to limit infiltration in the proposed system to less than 200 gallons per mile per inch diameter of pipe.

FIGURE 2S-I SEWAGE FLOW RATES ENTERING LIFT STATION AT NORTH END OF TOWN



Hydraulics of Sewers

The sewer system is considered as an open channel system for design purposes. An open channel is characteristically open to the atmoshere, and flows by gravity.

For most general design purposes, the formula most popularly used for computing flow rates and carrying capacities in sewer pipe is Mannings formula. The formula is written as:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

where n = coefficient of roughness

R = hydraulic radius, ft

V = velocity of flow

The quantity of flow is also determined by Mannings formula and is written as:

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

where Q = quantity in C.F.S.

and A = area of the pipe in square ft.

The hydraulic radius of the pipe is defined as the wetted perimeter divided by the Area of the pipe, or $\frac{\text{Dia.}}{4}$ for a pipe flowing full.

The roughness coefficient is usually assumed to be 0.013 to 0.015 for typical sewer pipe material. Typical n values for various types of pipes are presented in Table 2S-1.

TABLE 2S-1

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VALUES OF n TO BE USED WITH THE MANNING EQUATION [10] (7)

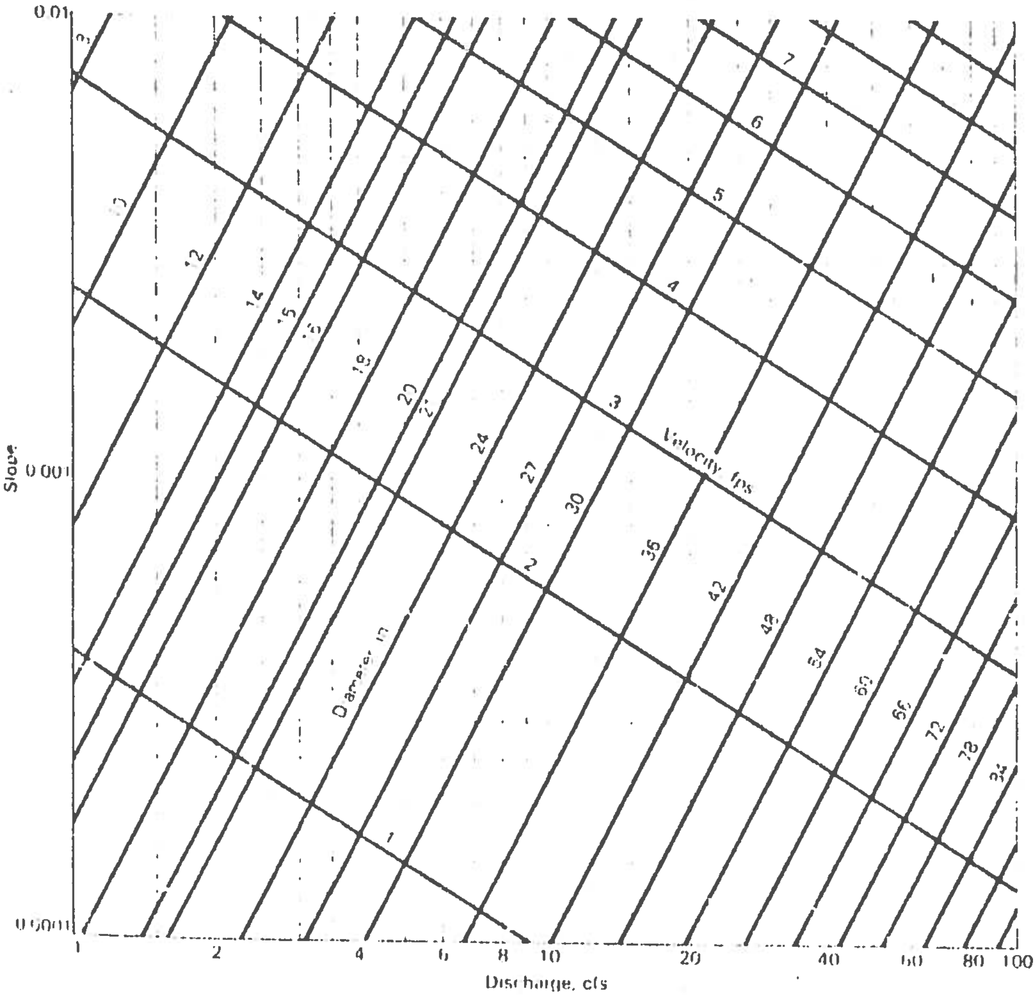
Surface	Best	Good	Fair	Bad
Uncoated cast-iron pipe	0.012	0.013	0.014	0.015
Coated cast-iron pipe	0.011	0.012*	0.013*	
Commercial wrought-iron pipe, black	0.012	0.013	0.014	0.015
Commercial wrought-iron pipe, galvanized	0.013	0.014	0.015	0.017
Smooth brass and glass pipe	0.009	0.010	0.011	0.013
Smooth lockbar and welded "OD" pipe	0.010	0.011*	0.013*	
Riveted and spiral steel pipe	0.013	0.015*	0.017*	
Vitrified sewer pipe	{0.010 0.011}	0.013*	0.015	0.017
Common clay drainage tile	0.011	0.012*	0.014*	0.017
Glazed brickwork	0.011	0.012	0.013*	0.015
Brick in cement mortar; brick sewers	0.012	0.013	0.015*	0.017
Neat cement surfaces	0.010	0.011	0.012	0.013
Cement mortar surfaces	0.011	0.012	0.013*	0.015
Concrete pipe	0.012	0.013	0.015*	0.016
Wood stave pipe	0.010	0.011	0.012	0.013
Plank flumes:				
Planed	0.010	0.012*	0.013	0.014
Unplaned	0.011	0.013*	0.014	0.015
With battens	0.012	0.015*	0.016	
Concrete-lined channels	0.012	0.014*	0.016*	0.018
Cement-rubble surface	0.017	0.020	0.025	0.030
Dry rubble surface	0.025	0.030	0.033	0.035
Dressed-ashlar surface	0.013	0.014	0.015	0.017
Semicircular metal flumes, smooth	0.011	0.012	0.013	0.015
Semicircular metal flumes, corrugated	0.0225	0.025	0.0275	0.030
Canals and ditches:				
Earth, straight and uniform	0.017	0.020	0.0225*	0.025
Rock cuts, smooth and uniform	0.025	0.030	0.033*	0.035
Rock cuts, jagged and irregular	0.035	0.040	0.045	
Winding sluggish canals	0.0225	0.025*	0.0275	0.030
Dredged earth channels	0.025	0.0275*	0.030	0.033
Canals with rough stony beds, weeds on earth banks	0.025	0.030	0.035*	0.040
Earth bottom, rubble sides	0.028	0.030*	0.033*	0.035
Natural stream channels:				
(1) Clean, straight bank, full stage, no rifts or deep pools	0.025	0.0275	0.030	0.033
(2) Same as (1), but some weeds and stones	0.030	0.033	0.035	0.040
(3) Winding, some pools and shoals, clean	0.033	0.035	0.040	0.045
(4) Same as (3), lower stages, more ineffective slope and sections	0.040	0.045	0.050	0.055
(5) Same as (3), some weeds and stones	0.035	0.040	0.045	0.050
(6) Same as (4), stony sections	0.045	0.050	0.055	0.060
(7) Sluggish river reaches, rather weedy or with very deep pools	0.050	0.060	0.070	0.080
(8) Very weedy reaches	0.075	0.100	0.125	0.150

* Values commonly used in designing.

It should be noted that commonly used values of n for PVC sewer pipe are 0.011 and 0.010.

Again as with the flow equations with water under pressure, the flow equations for flows in open channels have been made into nomograph forms as shown in Fig. 2S-2.

FIG. 2S-2



Nomograph for Manning's equation ($n = 0.013$) for flows between 1 and 100 cfs and slopes between 0.0001 and 0.01.

In the design of sewer collection systems, a very critical factor in determining the pipe size required is the velocity of flow. It is recommended that velocities in the pipe be no less than 2.0 to 2.5 f.p.s. This is the velocity required to self-scour, or keep the pipe clean and free from clogging.[40] The minimum slopes for various pipe sizes that will provide a scour velocity of 2.0 f.p.s. when using an n of 0.013, and the pipe is flowing fully are listed below:

Sewer Size Dia.	Minimum slope in feet per 100 feet
8 inch	0.40
10 "	0.28
12 "	0.22
14 "	0.17
15 "	0.15
16 "	0.14
18	0.12
21	0.10
24	0.08
27	0.067
30	0.058
36	0.046

The State D.E.Q. under most circumstances requires that no pipe smaller than 8 inch diameter be installed, and as with the water system, a signed permit to construct from D.E.Q. must be obtained by the contractor/developer prior to any sewer system construction.

Waste Water Characteristics

Although the analysis of Saratoga waste water is beyond the scope of this report, some important characteristics of waste water will be briefly discussed here. Analyses on waste waters may be classified as physical, chemical and biological.

Physical characteristics include solids in the water, temperature, color and odor. Chemical characteristics include organic and inorganic compounds, and gases. Biological characteristics include microorganisms, viruses, plants and animals. Typical composition of domestic sewage is summarized in Table 2S-2[7].

Physical Characteristics

The most important physical characteristic of waste water is its total solids content, which is composed of floating matter, suspended matter and matter in solution. Domestic solids include those derived from toilets, sinks, baths, laundries, garbage grinders, and water softeners[7]. Total solids (TS) are composed of suspended solids and filterable solids. Suspended solids are usually those solids that can be removed by settling. Filterable solids consist of colloidal and dissolved solids. Colloids are removeable by biologial oxidation or coagulation followed by sedimentation. Dissolved solids are more difficult to remove.

Color is usually an indication of the condition of sewage. Fresh sewage is usually grey, whereas older and septic sewage is usually black.

Odors are due to gases produced by decomposition of organic matter. Most fresh sewage has a musty or dirt type of smell. Old, stale sewage has a rotten egg smell usually caused by release of hydrogen sulfide in anaerobic (no oxygen) environments.

Chemical Characteristics

The chemical content of sewage is usually mostly organic in nature. Organic compounds are characteristically composed of carbon, hydrogen and oxygen, and nitrogen in some cases. Proteins, carbohydrates, fats, oils, and urea are the major organic components of sewage. The measurement of organic content in sewage can be done using several different test methods. The three most popular are BOD, COD and TOC.

BOD is the biochemical oxygen demand exerted by the sewage. The determination involves the measurement of the dissolved oxygen consumed in a sample of sewage over a 5 day period by the microorganisms in the biochemical oxidation of the organic matter. The BOD measurement is significant because it is used to determine the approximate quantity of oxygen that will be required to stablilize biologically the organic matter present. The general process behind biochemical oxidation is that the microorganisms in waste water consume the organic matter in the water. This consumption is an aerobic process, which means the microorganisms responsible for the breakdown of organic compounds require oxygen to survive and metabolize.

COD is the chemical oxygen demand. This is a test used to measure the content of organic matter in waste water. It is a complex test method to perform, however, it is a much quicker test usually accomplished in 3 hours instead of 5 days like the BOD. The principle is that the organic material in the waste water is oxidized by a chemical oxidizing agent, instead of microorganisms. The results of the test give a good indication of the oxygen required to oxidize other oxidizable materials in addition to the organic compounds.

TOC is the total organic carbon content and is generally used where small concentrations of organic matter are present. The method is simple to perform but requires quite elaborate equipment.

Inorganic components found in waste water include pH, alkalinity, nitrogen, phosphorus, sulfur, heavy metals and gases. The important components in domestic sewage are usually the gases as they give an indication of the condition of the sewage.

The dissolved oxygen, D.O., in waste water is required for respiration of the aerobic microorganisms as well as all other aerobic forms of life. When dissolved oxygen is present, usually no offensive gases are produced in the system.

Hydrogen sulfide, rotten egg smelling gas, is formed from the decomposition of organic matter containing sulfur or from the reduction of mineral sulfates and sulfites. It is not formed in the presence of an abundant supply of oxygen.

Methane, or "sewer gas" is a colorless, odorless, combustible gas that is dangerous. Again, methane is rarely formed and does not exist in the presence of oxygen.

Biological Characteristics

Biological aspects of waste water are very important to the treatment of the waste. The principal group of organisms found in waste water are microorganisms which include bacteria, fungi, protozoa and algae, and viruses.

Coliforms as discussed in the water section of this report are found in the intestinal tract of man. Each person discharges from 100 to 400 billion coliform organisms per day in addition to other kinds of bacteria.[7] Pathogenic or disease causing organisms are also discharged by humans who are infected with disease. But because the numbers of pathogenic organisms present in waste water are few and difficult to isolate, the coliform organism which is more numerous and more easily tested for, is used as an indicator organism. There are several accepted methods to test for the presence of coliforms, the most reliable of which is the membrane-filter technique.

Algae can be an important component of waste water particularly in the lagoon system. Algae are aquatic plants which flourish in lagoons during the summer. The significance of the algae is that they,as all plants, produce oxygen through their normal respiration process. The oxygen is valuable to the aerobic organisims in the lagoon and can be an aid to sustain them. However, if discharged, or in the the fall when light and temperature decrease, the die off of algae can produce a serious BOD loading on the system.

Viruses can best be described as non living matter which exhibit some characteristics of living organisms. Virus are composed of proteins, similar to the genetic materials that control heriditary make up. They can be activated, or inactivated, but not killed, as they are not living. Viruses that are excreted by humans may become a major hazard to public health. For example, from experimental studies, it has been found that from 10,000 to 100,000 infectious doses of hepatitus virus are emitted from each gram of feces of a patient ill with this disease. It is known that some viruses will remain active as long as 41 days in water at 20°C.[7] Viruses are a heavily studied, but not well understood group of organisms, which many researchers now believe to be the cause of some types of cancer. Viruses are very difficult to isolate and identify.

TABLE 2S-2 (7)

TYPICAL COMPOSITION OF DOMESTIC SEWAGE

(All values except settleable solids are expressed in mg/liter)

Constituent	Concentration: Strong	Concentration: Medium	Concentration: Weak
Solids, total	1,200	700	350
Dissolved, total	850	500	250
Fixed	525	300	145
Volatile	325	200	105
Suspended, total	350	200	100
Fixed	75	50	30
Volatile	275	150	70
Settleable solids, (ml/liter)	20	10	5
Biochemical oxygen demand, 5-day, 20°C (BOD_5, 20°)	300	200	100
Total organic carbon (TOC)	300	200	100
Chemical oxygen demand (COD)	1,000	500	250
Nitrogen, (total as N)	85	40	20
Organic	35	15	8
Free ammonia	50	25	12
Nitrites	0	0	0
Nitrates	0	0	0
Phosphorus (total as P)	20	10	6
Organic	5	3	2
Inorganic	15	7	4
Chlorides*	100	50	30
Alkalinity (as $CaCO_3$)*	200	100	50
Grease	150	100	50

* Values should be increased by amount in carriage water.

CHAPTER 3S - TREATMENT, DISINFECTION, AND DISCHARGE

Treatment

Treatment of sewage is an attempt to remove the nutrients and oxygen consuming compounds from the waste water prior to discharging the waste water into a receiving water. The degree of treatment can be divided into three general categories.

1. Primary treatment, which involves settling, and some reduction of BOD_5 but no major mechanical means of treatment is used.

2. Secondary treatment involves mechanical means of treatment usually including primary settling, degritting, etc., aeration, filtration, and sludge handling.

3. Tertiary treatment is additional treatment beyond the scope of secondary treatment, which involves highly sophisticated and expensive processes to reduce the contaminants and quantities of particulates to a level similar to that of potable drinking water. Tertiary treatment is employed in areas where the discharge requirements demand a highly polished water, such as mountain resorts, and communities that discharge into a high quality receiving stream.

The Towns treatment responsibilities are dependent upon discharge requirements in the discharge permit issued by the State D.E.Q. The permit, number Wy-0021491, is included in the Appendix for easy reference. The responsibility of the design Engineer in proposing waste treatment methods or facilities for Saratoga will be to provide treatment that will not only meet the present day requirements, but be capable of meeting the more demanding requirements proposed for the near future.

In 1972, the Federal Water Pollution Control Act called for all communities to gear up to provide treatment that would meet or exceed National Secondary Waste Treatment Standards, by July 1,1977.

The stated objective of the Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. In order to achieve this objective, the following goals were established.[39]

1. Not later than July 1, 1977, appropriate effluent limitations for publicly and privately owned treatment works shall be required in order to provide for recreation on the water and protection of aquatic life.
2. Wherever attainable an interim goal of water quality which provides for protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water shall be achieved by July 1, 1983.
3. Elimination of the discharge of pollutants to navigable waters by 1985.

This Act put a financial burden on most communities so enforcement of the Act was changed to allow communities to apply for relief from the July 1, 1977 deadline, if the community has not received Federal Construction grants, and if the community specifically makes the request. This request would give the Town until July 1, 1983 to meet the Secondary Treatment Standards.

The present discharge limitations as of October 18, 1977, on the Towns waste discharge permit are summarized below:

Parameter	Monthly Avg.	Weekly Avg.
BOD_5	30	45
TSS	100	150
Fecal coliform	variable depending on receiving stream and dilution factor	
Total residual chlorine	variable depending on receiving stream and dilution factor	
pH	6.0 - 9.0	

In addition, the receiving stream is the North Platte River and it is classified as a Class I river. Class I rivers are described as those waters which are determined to be supporting game fish or have the hydrologic and natural water quality potential to support game fish.[39]

The scope of this report is to point out and propose solutions to the immediate problems of the sewer system. Although all elements of the waste collection system will be covered in this report, the only items covered in detail will be the sewer collection system and the existing waste disposal process. More advanced treatment processes of the extent required by the Water Pollution Control Act are beyond the Scope of this report, and will be required to be thoroughly studied prior to any major advanced treatment construction project which would use Federal EPA funds.

PART IV

SANITARY SEWER SYSTEM
ANALYSIS, EVALUATION AND RECOMMENDED CONSTRUCTION

CHAPTER 4S - COLLECTION SYSTEM AND OUTFALL LINE

Scope

The scope of this Chapter of the report is to describe, examine and evaluate the existing sewerage system, and make recommendations for improving and upgrading the system.

General

Any discussion concerning evaluation of the existing system and possible upgrading, must first include a description of the terrain the system exists in. The sewer systems carry the waste water by gravity flow. Therefore, it is obvious that a brief description of the surface and subsurface conditions is necessary before a fair evaluation of the existing system can be made.

The surface conditions in the Town of Saratoga vary from very flat to rather steep hills. The older part of Town is built near the river, and this area is fairly flat. The newer parts of Town have been built up away from the River and are on more sloping ground and hills. The older part of Town is built below the level of the Hugus-Mullison irrigation ditch. Seepage from this ditch and the high levels of the river during the spring and early summer months cause high ground water to exist between the level of the ditch and the river channel. Many reports and studies have been done on how to alleviate the underground seepage from the ditch to the river, since it is a major cause of high water problems for those residents below the ditch. However, the ditch problems are beyond the scope of this report, and will only be mentioned briefly herein.

Subsurface conditions consist of the river cobbles and pit run sand layers typical of a soil in an old glacier field and river bed terrain. For the most part, large cobbles 6 - 12 inches in size can be found mixed with pit run gravel and sand within 1 to 10 feet of the surface anywhere in the Saratoga area. The closer to the river, the closer the gravel formations are to the surface. On the hills around Town the soil consists of a fine blow sand type of top soil, underlain with various layers of sand, cobbles and gravel.

Extensive bedrock is prevalent in the Saratoga Inn area.

The high ground water situation combined with the large river cobbles and pit run gravel place a burden on any construction of sewer lines which may be proposed. The sewer system must be designed and constructed in such a way as to drain all waste water to one collection point by gravity. The system cannot be raised or lowered in certain areas to avoid undesirable formations or ground waters.

With the surface and subsurface conditions briefly described, it is recommended that any proposed construction of sewer (or water lines) be designed to meet the rather difficult conditions found in Saratoga. The quality of construction will be governed by the quality of material and methods used in placing the material.

Description of the Existing Collection System

The existing waste water collection system is shown on Figs.5S-8 & 10 of the sewer system maps. Most of the system and its problem areas have been called out on the Figure. In general, those areas in the older parts of Town have the old Orangeburg or clay type sewer pipe, which is prone to tree root ingrowth and consequential clogging.

The system west of the river consists of many laterals that connect individual services. These laterals run into larger main lines and then tie into the main 10 inch diameter collector line which runs north and south on Third St. The waste collected in the main line flows north and then east into a sewage lift station. The lift station which was constructed in 1972, collects the sewage from all of Saratoga west of the North Platte River, and pumps it over to the east side sewer system, and outfall line.

The east side sewer system, constructed in 1956 and 1962, collects waste water from the Saratoga Inn, and those residents on the east side of the Platte River. The waste flows northerly into a 10 inch diameter outfall line which carries the waste water 3900 feet to the waste water lagoons.

Evaluation of the Existing System

In evaluating the existing waste water collection system, probably the largest single contributor to the many problems that exist is the high ground water caused by the seepage from the Hugus-Mullison Irrigation Ditch. The high ground water results in infiltration of water into the sewer lines and contributes to overloading of both the collector lines and the sewage lift station. The other major problem with the system is that the areas to be serviced in the older part of Town are so flat, that it is difficult to provide enough slope to maintain a scour velocity for self cleansing flows, or to maintain adequate ground cover to prevent winter freezing.

The entire sewer system and future contemplated sewer systems are all governed by the elevation of the lagoon. All waste water must flow by gravity to the lagoon. Thus the elevations of the present system govern any future growth and all improvements to the existing system. Unless the entire system is reconstructed, the flat shallow sewer lines will continue to be flat and shallow, but some improvements are possible.

Figs. 5S-8 & 10 shows the existing system, the corresponding problem areas, and some critical flows and elevations obtained by W.E.A.I. field crews. Fig. 5S-12 shows the major existing and proposed sewer collector lines and their population equivalents.

Evaluation of the system began in the Spring of 1977. Several unfortunate residents were subjected to backed up sewers, and flooded homes. W.E.A.I. monitored the main collector lines and corresponding manholes throughout the Spring and early Summer. Flow measurements were calculated and recorded in many critical parts of the system.

The 10 inch diameter collector line was monitored for 36 hours on two occasions. The flow during the peak hours were compared to flows during the middle of the night to determine the volume of infiltration. Our results shown in Figure 2S-1 indicate as much as 0.6 C.F.S. infiltration occurs in the 10 inch line. This is more than one half of the total flow that the line is capable of carrying. The total carrying capacity of the 10 inch line on Third Street is

0.73 C.F.S. This amount of infiltration is equal to a population of 2100 people and cuts the carrying capacity of actual sewage to about 1000 people. Thus the line becomes overloaded and begins to back up. In addition, that section of 10 inch sewer on Third Street between Rochester and Hugus Street is a bottle neck for the remainder of the line. The capacity in this location is .73 C.F.S. or 3100 people, but the velocity of flow is only 1.34 f.p.s., inadequate for self scouring.

In addition to the main line on 3rd Street backing up due to infiltration, the other cause of that line backing up was due to a poorly operating lift station. The lift station pumps that sewage from the west part of Town across the Highway to the east. When the lift station goes out of service the waste quickly backs up the Third Street main.

The existing lift station prior to being renovated in 1978 was installed in 1972. It was a packaged lift station which consisted of two air vacuum primed sewage lift pumps that pumped waste from a concrete wet well. These pumps were very difficult to prime, and clogged easily. The controls on the system were far more complicated than necessary, and thus required continual maintenance and repair. The lift station simply was inadequate.

In late fall **1977, W.E.A.I.** redesigned the lift station for renovation into a more reliable system. The two air vacuum primed pumps were replaced with two submersible non-clogging sewage pumps. These pumps require no priming, and have a recessed impeller that does not come into contact with the sewage. Each pump was designed to pump the maximum capacity of the line serving the lift station, 500 g.p.m. Therefore, one pump is to be used all the time, the other as a backup, and both can be used if future expansion occurs. Simple float controls were designed and installed that turn the pump on or off with the rising liquid levels in the wet well. With a fully reliable lift station, the back up problems due to the previous lift station failures on the west side of Town were solved.

In addition to the back up problems experienced on the west side of Town, the east side of Town also had problems. The outfall line backed up all the way from the lagoons, and caused flooding of trailer homes and other residences on the eastern side. The cause of this was that the volume of sewage and infiltration water being pumped from the lift station on the west side of Town was considerably more than the 10 inch outfall line and 10 inch diameter lagoon piping could carry. The capacity of the 10 inch diameter outfall line is 0.9 C.F.S. In the summer of 1977, W.E.A.I. recommended that to immediately alleviate this problem of temporary drainage channel at the lagoon should be dug to help drain the lagoons more quickly. W.E.A.I. also recommended that the Town immediately apply for funding to increase the size of the outfall line and lagoon piping. The recommended construction was designed to carry the flows of a population of 10,000 people or 3.7 C.F.S. in addition to the 0.85 C.F.S. capacity of the existing 10 inch diameter outfall line. A 15 inch diameter outfall line was recommended. In addition the lagoon piping connecting the two present lagoons, and the effluent piping discharging from the lagoons were increased to provide a flow through capacity for a population of 10,000. This construction was funded by a State Mineral Royalties Grant obtained in the Spring of 1978, and construction was started in May, 1978.

Evaluation of the remainder of the system is summarized as follows:

1. The sewer system serving the Eastern part of Saratoga appears to be adequate both now and in the future.
2. The sewer system serving the Country Club Heights Addition was constructed in 1972. This system appears to be adequate at present and can adequately handle future expansion.
3. The sewer system in the flat part of Town between the Hugus-Mullison ditch and the North Platte River, is in poor to unacceptable condition as referenced on Fig. 5S-8. The reasons being due to one or several of the following:

    a. The sewers that freeze up are both too shallow and too flat to keep water from freezing in the winter.
    b. The sewers that are too flat are so because they must be drained by gravity into the Third Street main, and must therefore be higher in elevation than the Third Street main.

c. Some sewer tile is broken due to the type of rocky soil surrounding the tile, the quality of construction, or depth of cover, or failure of the pipe material.

d. The sewers that are leaking are doing so due to failure of materials, freezing causing cracking, etc. or the way the pipe was bedded or backfilled.

e. Much 6" line exists that should be 8".

It should be pointed out that most of the sewer pipe material in this part of Town is vitrified clay pipe. Unless this type of pipe is properly bedded and covered with fine material, and backfilled properly during construction, it is subject to breakage. Improper construction control probably caused the majority of broken or clogged sewer pipe. In addition, this pipe was installed with open joints which is conducive to tree root growth and cracking at the joints of the pipe. This open joint pipe is the reason for the major infiltration problem.

4. The sewer system serving the newly developing area above the ditch west of Town is inadequate. The system is 6 inch diameter, in many streets, and thus cannot reliably handle large sewage flows. The entire area drains to one common manhole between Saratoga and Rochester St. on 6th, and a 6 inch line carries all that flow across the slough and ties into the main on Third St. The capacity that this 6 inch sewer can carry, is equivalent to less than 1500 people. With increasing development in this area, this line will become overloaded and present another backup problem.

5. The 10 inch diameter main sewer collector on Third Street was constructed in 1950. It is vitrified clay pipe, and thus is suspect of being cracked, broken and/or clogged with tree roots. Its population equivalent is a capacity of 3100. This is the main collector, and unless the infiltration is eliminated the rapid growth on the western bench and southern hill will overload the 10 inch collector, even when infiltration is at a minimum.

6. Many of the shallow sewers drain to lamp holes or "light boxes", that have steel plates for covers. These covers are not capable of being anchored easily, and are dislodged by traffic. These lamp holes then fill with dirt and debris and require frequent rodding.

7. The homes on Saratoga Inn Subdivision Number I and II, are not on a sewer system. Each home has a septic tank and leach field located in the water table of the river. Since these homes are upstream of the water plant intake and the river also serves as the source of water supply, these septic tank systems present a potential health hazard through contamination of the drinking water supply. These homes should be connected to the sewer system. However, construction of a feasible and economic sewer system for this area may prove very difficult to accomplish.

The Saratoga Inn area is located along the flat low areas of the Platte as shown on the Maps. Subsurface soil and geotechnical investigations performed in early 1978 showed varying ledge rock elevations, making sewer or water line construction extremely difficult. In addition, a possible fault line exists in the area. Many subsurface hot springs were located and many residents express fear that any excavation may damage the flow of warm water to the Hobo Pool, and thus damage this fine year round tourist attraction. W.E.A.I. performed subsequent testing and proposed the sewer system shown on Figs.5S-9 & 5S-11. This system may require two or more lift stations to pump the sewage from the lower areas into the existing east side sewer system. The results and conclusions obtained in our early 1978 investigations during the EDA funded water and sewer project are presented in the Appendix.

Recommended Construction

The recommended construction and its features for improving and renovating the sewage collection system is shown on Figs. 5S-9 and 5S-11 and summarized as follows:

1. Construct a 10 inch diameter by-pass line as shown on Fig. 5S-9 from the manhole between Saratoga and Rochester

Street , on 6th Street to the north on 6th Street, and then east along the back side of the Hugus St. property to tie into the manhole on Third Street. This bypass will take the loading from the West Hill and all future development, off the Third Street main collector line. The 6 inch diameter line that runs down the alley between Saratoga and Rochester, and Sixth and Third Street, should then be abandoned.

2. Construct a 10 inch diameter bypass line from the south hill area and run it across the River to the Saratoga Inn area as shown on Fig. 5S-11. The features of this construction are that (1) the loading from the South Hill area and all future development there will be taken off the Third Street main collector line, and (2) it provides a main sewer line which is accessible for the Saratoga Inn Subdivision to tie on to and abandon their septic tank system.

   Construction of this 10 inch diameter bypass was begun in January, 1978 by the Town of Saratoga and funded by a $232,000 grant from the Economic Development Authority. The capacity of the new line is 1.67 C.F.S. or a population equivalent of 6300 although the line it ties into is limited to .89 C.F.S. or 3800 people. A sewage lift station was required on the project to lift the sewage into the existing system and run it into the outfall line. The lift station is of the same design as the renovated station on the west side of Town. It contains two submersible, non-clog sewage pumps, one in full time service, and the other a standby system.

3. The renovated lift station serving the west side of Town, and the lift station under construction at the Saratoga Inn should both be provided with reliable standby power generators that will automatically come on in case of power failures. It is estimated that the standby power required for the west side lift station be a minimum of 15 KW, and the Saratoga Inn Lift Station have a minimum standby power of 10 KW.

4. Seal and/or replace any broken sewer tile on the Third Street main collector line. This should relieve some of the infiltration problems with this main collector. The estimated cost of construction is shown in Table 4S-1.

5. Construct a 10 inch bypass line around the existing system on the west part of Town above the ditch. The newer sewer system installed in that area consists of many 6 inch diameter lines that are not capable of serving as collectors. These lines cannot be tied onto as the area develops in the near future. This proposed 10 inch bypass line will tie into the proposed 10 inch bypass line recommended in paragraph 2 previously and is shown on Fig. 5S-9 & 12.

6. Seal or repair the many small collector lines throughout Town that have infiltration, clogging or rodding problems as referenced on Fig. 5S-8 & 10. W.E.A.I. recommends that where the existing sewers are too shallow and/or flat to prevent winter freezing, that the sewers be replaced with double insulated water line pipe similar to Temp Tite water pipe produced by Johns Manville. In addition, shallow sewer pipe can be backfilled with a layer of saw dust or wood chips to prevent frost from reaching the pipe. The extra cost of this special pipe material and special back-filling required should be overcome in a few years by the savings from the Town crews not having to maintain and keep the lines from freezing and clogging during the winter.

7. After sealing and replacement of lines below the Hugus-Mullison Ditch excessive infiltration might still exist as many home owners pump excess ground water into the sewer system to keep their basements from flooding. If this is the case then the Hugus-Mullison Ditch will have to be sealed.

8. In conjunction with all of the recommended and proposed construction, it is again important to point out that any construction of sewer or water improvements no matter how small or large must be approved by the State Department of Environmental Quality, and a D.E.Q. "permit to construct", be obtained by the Contractor prior to any construction. The plans for proposed improvements must be submitted to D.E.Q. by a professional engineer licensed in the State of Wyoming. These plans are then reviewed by D.E.Q. and a "permit to construct" is issued or denied.

This process insures that any improvements or proposed construction will meet the required engineering, health and construction standards. This process protects the Town from poor quality materials and construction, and the inadequate line sizing that presently plagues Saratoga.

Full time inspection by a qualified inspector is necessary if proper construction is to be obtained.

TABLE 4S-1

COST ESTIMATES FOR PROPOSED 1978 SEWER IMPROVEMENTS

NEW 15" OUTFALL

ITEM	DESCRIPTION	UNIT	UNIT PRICE	EXTENSION
1	15" Outfall line	3810 l.f.	$ 22	$ 83,200
2	Manholes on 15" line	10 ea.	1000	10,000
3	Piping throughout existing pond area to transport flows	L.S.	30000	30,000

SUB TOTAL CONSTRUCTION:	$123,820
10% CONSTRUCTION CONTINGENCY	12,382
ENGINEERING 8%	10,896
SURVEYING	4,000
INSPECTION 3%	4,086
ADVERTISING, LEGAL, ADMINISTRATION	2,000
TOTAL =	$157,184
USE	157,000

SEAL EXISTING OVERLOADED MAINS

ITEM	DESCRIPTION	UNIT	UNIT PRICE	EXTENSION
1	Seal 6", 8" & 10" mains (includes TV monitoring of joints)	17,800 l.f.	$ 4	$ 71,200
2	Replace broken tile	200 l.f.	20	4,000

SUB TOTAL CONSTRUCTION:	$ 75,200
10% CONSTRUCTION CONTINGENCY	7,520
ENGINEERING 8%	6,618
INSPECTION 3%	2,482
ADVERTISING, LEGAL, ADMINISTRATION	1,000
TOTAL =	$ 92,820
USE	93,000

TOTAL =$250,000

ALTERNATE - REPLACE MAJOR BROKEN MAIN, SEAL OVERLOADED MAINS

ITEM	DESCRIPTION	UNIT	UNIT PRICE	EXTENSION
1	Replace 8" & 10" old main w/10" main	2800 l.f.	$ 25.00	$ 70,000
2	Manholes on 10" main	8 ea.	1,000.00	8,000
3	Seal remaining 6" & 8" lines	15000 l.f.	4.00	60,000

SUB TOTAL CONSTRUCTION =	$ 138,000
10% CONSTRUCTION CONTINGENCY	13,800
ENGINEERING 8%	12,144
SURVEYING	4,000
INSPECTION 3%	4,554
ADVERTISING, LEGAL, ADMINISTRATION	2,000
TOTAL =	$ 174,498
USE =	175,000

TOTAL NEW 15" OUTFALL AND ALTERNATE MAIN = $ 332,000

CHAPTER 5S - TREATMENT, DISINFECTION AND DISCHARGE

Scope

The scope of this Chapter of the report is to describe, examine and evaluate the existing treatment process including disinfection and discharge, and make recommendations for improving the system. Although this report will make recommendations to solve the more immediate problems, any long term plans and proposals will require further, more detailed study if the National Secondary Waste Water Standards are to be met.

Description of the Existing Waste Water Treatment System

The existing treatment consists of a two cell lagoon system located North of Town. Both cells are 10 feet deep and both cells have approximately 52,000 square feet of surface area when full. The Southern cell has two 5 Horse power aerators that are controlled by a time clock. The two cells are interconnected via a 10 inch diameter, and a proposed 18 inch diameter overflow pipe. The waste that leaves the Northern cell leaves via a proposed 20 inch diameter effluent line in which a flow measuring flume is proposed to indicate and record the quantity of fluid passing through the system. The 20 inch diameter effluent pipe runs into a large baffled chlorine contact basin. The waste then flows from this basin, into a winding drainage ditch that eventually returns the waste effluent to the North Platte River.

The treatment involved is best described as mostly physical settling, with some BOD removal occuring through aerobic metabolism. The aerators located in the southern cell provide air and some mixing to the contents of the lagoon, to aid in the aerobic digestion process. Algae grows abundantly and adds additional oxygen to the system in the summer.

Chlorination capabilities exist at the lagoon effluent, for removal of bacteria from the effluent, as the permit limits the number of fecal coliforms allowed in the effluent.

Evaluation of the Existing Tre tment System

The existing treatment system is inadequate for the present population of 2700 it serves. The system is at maximum capacity at a population of 1800. The volumetric and organic loadings are in excess of the maximum design loadings typical of aerated lagoon systems. Each spring when the ice melts from the lagoon, the lagoon produces offensive odors. The reason for the odor is a lack of oxygen in the cells. Oxygen is required for the aerobic digestion processes that occur in the lagoon. If there is no oxygen, the ponds turn anaerobic, and these conditions cause formation and release of offensive gases. Whenever these odors begin to occur, the problem is usually due to lack of enough oxygen to keep the lagoons in an aerobic condition.

Close examination of the existing system and Table 5S-1 shows that for a population of 2500 the average winter detention time of waste water excluding any infiltration flows in the two cells is less than 20 days, but that 30 days are required for 85% BOD_5 removal. The aeration requirements for a population of 2500 people are 788 pounds per day, or a power requirement of approximately 20 H.P., double that of what actually exists.

Hydraulic analysis shows that for an 85% BOD_5 removal during winter, and a 90% BOD_5 removal during summer, an additional 4½ acre cell 10 feet deep will be required, and 40 H.P. will be required to provide adequate aeration for a population of 5000. A population of 10,000 will require 11.3 additional acres of lagoon storage 10 feet deep and 81 H.P. will be required for aeration.

These large lagoon sizings are caused by low theoretical winter efficiencies for B.O.D. reductions and large per capita flows. When adequate aeration is provided actual operating tests and flow measurements will possibly show that the large theoretical detention times are not required. We, therefore recommend routine effluent anaylsis and flow recordation to determine actual field efficiencies and flows.

In addition, the discharge permit presently requires reduction in fecal coliforms. The present chlorination system at the lagoon is not operable, and hasn't been for two years. No testing has been performed to monitor fecal coliform levels. Chlorine is an acceptable disinfectant and should be adequate in maintaining coliform levels if long enough detention times are provided. The detention time in the present contact chamber is about 55 minutes for a population of 2500. Detention times of 90 minutes at normal dose rates of 1 - 2 p.p.m. are usually required for good fecal coliform removal. The chlorine dosing should be capable of being proportioned to the varying flow rate through the ponds. The present system is not capable of accomplishing this.

Chlorine has recently come under attack as producing carcinogenic by products, called chlorinated hydrocarbons. In addition chlorine indirectly exerts an oxygen demand in the receiving streams by killing organisms thus causing an oxygen demand and risking the possibility of reducing the oxygen content of the river. Chlorine is also toxic to trout in very low concentrations.[23] For these reasons and others beyond the scope of this report, W.E.A.I. recommends that thorough study of the possibility of disinfection with Ozone be undertaken before major renovation or new construction of the chlorine system is contemplated.

Ozone has several advantages over chlorine in disinfection, mainly that it is 3 times as effective and faster acting than chlorine. Ozone would require less detention time and thus eliminate the expense of building large detention tanks. Ozone is not suspected of forming toxic or carcinogenic by products. And ozone is not toxic to fish, mainly because of its very short life. Ozone is only active for 20 to 30 minutes, and then it reverts back to oxygen. This would indicate that no oxygen depletion should occur, but just the opposite. Ozone may eliminate the oxygen sag caused by dying algae and bacteria which typically occurs downstream in waste treatment system effluents.

Tables 5S-2 and 5S-3 show the estimated cost of constructing a lagoon system for a population of 5000 and 10,000 respectively. However, we do not recommend immediate construction of the 11.3 acre third cell, required by a population of 10,000.

The National Water Pollution Control Act may be enforced in 1983 or may be postponed further. More thorough examination of the Act, and the present waste treatment efficiency is required before recommending construction of a nearly 1.0 million dollar project. In addition, the rate and quality of growth in Saratoga over the next 5 years may provide the necessary information as to what kind of treatment processes can be used to meet the standards. At present, we feel that the aerated lagoon system is an adequate and inexpensive treatment process capable of meeting the present discharge standards and discharge permit requirements.

Currently, the State D.E.Q. is not requiring sewage treatment construction unless the Town can obtain a 25% local, 75% Federal matching grant.

Recommended Construction

1. Increase the number of aerators in the existing lagoon cells, to maintain a dissolved oxygen level of at least 1 p.p.m. and eliminate the spring and fall stench. For a population of 2500, two more 5 H.P. aerators are required.
2. Begin applying immediately for funding for construction of a 4½ acre pond, Cell #3. The estimated cost of construction is shown in Table 5S-2.
3. Immediately rennovate and put back into service the inoperable chlorination system on the lagoon effluent. The chlorination system installed should be a flow proportional system that automatically adjusts the dosage rate with varying flow rates. The chlorine added and chlorine residual obtained

should be routinely monitored, and records kept to comply with the discharge permit.

4. Begin a routine monitoring and testing program of the parameters involved in the lagoon treatment process. These parameters are:

    a. Temperature.
    b. Oxygen content of the lagoon influent and effluent.
    c. Flow rates, daily average and peak.
    d. BOD_5 levels of the lagoon influent and effluent.
    e. Total solids, suspended solids and volatile solids concentrations in both the influent and effluent.
    f. Fecal and total coliform levels in the influent and effluent.

    The purpose for recommending this monitoring program is two-fold: (1) it provides the operator with the type of data he will need to maintain the lagoon treatment efficiency in compliance with the discharge permit, and (2) it will provide valuable data for future Engineering studies and construction funding applications. In addition knowing the quality of the discharge will be helpful in determining the degree of treatment required to meet the National Secondary Treatment Standards. There are funds available for some of the expenses incurred for this type of "pre-design" or "pre-application" planning.

TABLE 5S-1

TREATMENT CHARACTERISTICS

AND

REQUIREMENTS FOR VARIOUS SIZE LAGOON SYSTEMS

POP.	BOD (.25 ppd cap.)	DAILY FLOW gallon	DAILY OXYGEN required	HOURLY OXYGEN required	HOURLY HP FOR aerator	H.P. REQ'D. Mixing	LAGOON ACREAGE required
2500	625	375,000	788 ppd	33 lb.	20.25	84	0.95
5000	1250	750,000	1576 ppd	66 lb.	40.5	168	4.41
7000	1750	1,050,000	2205 ppd	92 lb.	56.4	236	7.17
10000	2500	1,500,000	3152 ppd	132 lb.	80.73	338	11.31

Assume $\frac{200\ \text{mg}}{1}$ ∴ $x\ \frac{3.78\ 1}{\text{gal.}} \times \frac{\text{lb.}}{454{,}000\ \text{mg.}} = \frac{.25\ \text{lb.}}{\text{day per capita}}$

$$d_{t_w} = \frac{85}{15\ (Ka)_{1^\circ C}} = \frac{85}{15(.19)} = 29.82 \text{ days} = 30 \text{ days}$$

$$d_{t_s} = \frac{90}{10\ (Ka)_{16^\circ C}} = \frac{90}{10\ (.56)} = 16 \text{ days}$$

$$O_{2_r} = \frac{(BOD_5)(Q)(8.34)(10^{-6})(L)(F)}{24} \quad \text{eg. 5000 pop.} = \frac{66 \text{ lb.}}{\text{hr.}}$$

$$FTR_{16^\circ} = \frac{3.0\left[7.5(.95)-1\right]\ (.9095)\ (.90)}{9.2} = 1.63 \text{ lb./hp/hr.}$$

Vol. = 30 days x pop. x 150 gpcpd

Vol.2,500=11.25 MG

Vol. 5,000=22.5 MG

Vol.10,000=45.0 MG

$$\text{Area} = \text{Vol.} \times \frac{1 \text{ cu. ft.}}{7.48 \text{ gal.}}\ \frac{}{10 \text{ ft.deep}} = \frac{\text{sq.ft.}}{43{,}560} = \_\_\_\_ \text{Acres}$$

A_{2500} = 150,401 sq.ft. = 3.45 Ac.-2.5Ac.= .95Ac. Required

A_{5000} = 300,802 sq.ft. = 6.91 Ac.-2.5Ac.= 4.41Ac. Required

A_{10000} = 601,604 sq.ft. =13.81 Ac.-2.5Ac.= 11.3 Ac. Required

A_{7000} = 421,123 sq.ft. = 9.67 Ac.-2.5Ac.= 7.17Ac. Required

TABLE 5S-2

ESTIMATE COSTS OF LAGOON IMPROVEMENTS FOR 5000 PEOPLE

ITEM	DESCRIPTION	UNIT	UNIT EA.	EXTENSION
1.	Extend lagoon piping	L.S.	L.S.	10,000
2.	Overflow weir box w/scum baffle	1 ea.	L.S.	5,000
3.	Chlorination - flow proportional 25 ppd	lea.	L.S.	12,000
3A.	Ozonation - flow proportional - 15 ppd	2 ea.	50,000	100,000
4.	Chlorine contact Chmbr.- concrete w/baffles, 10' deep	1 ea.	L.S.	75,000
4A.	Ozone contact Chmbr.- 20' deep and building	1 ea.	L.S.	42,500
5.	Lagoon excavation 10' deep	112,000 cu.yd.	1.50/cu.yd.	168,000
6.	Lagoon sealing	197,000 sq.ft.	.10/sq.ft.	19,700
7.	Compacted side slopes	3,800 cu.yd.	2.50/cu.yd.	9,500
8.	Sealed discharge ditch	750 cu.yd.	1.80/cu.yd.	1,350
9.	Aerators and controls (10 H.P.)	3 ea.	7,500	22,500
10.	Fence	1,800 l.f.	5.00/l.f.	9,000

COST OF CONSTRUCTION	332,050
10% CONTINGENCY	33,205
	365,255
ENGINEERING 7%	25,568
Surveying & Staking 1.5%	5,479
Inspection 3%	10,958
Administration and Adv. 1%	3,653
TOTAL CONSTRUCTION COST:	$410,913
USE:	411,000

TABLE 5S - 3

ESTIMATED COSTS OF LAGOON IMPROVEMENTS FOR 10,000 PEOPLE

ITEM	DESCRIPTION	UNIT	UNIT EA.	EXTENSION
1.	Extend lagoon piping	L.S.	L.S.	12,000
2.	Overflow weir box w/scum baffle	1 ea.	5,000	5,000
3.	Chlorination - flow proporational 50 ppd	1 ea.	L.S.	15,000
3A.	Ozonation - flow proportional - 25 ppd	2 ea.	60,000	120,000
4.	Chlorine contact Chamber w/baffles 20 ft. deep	1 ea.	L.S.	150,000
4A.	Ozone contact chamber concrete 20' deep and building	1 ea.	L.S.	72,500
5.	Lagoon excavation 10' deep	223,000 c.y.	1.50/c.y.	334,500
6.	Lagoon sealing	585,000 sq.ft.	.10/sq.ft.	58,500
7.	Compacted side slopes	6,637 cu.yd.	2.50/c.y.	16,593
8.	Sealed discharge ditch	700 cu.yd.	1.8 /c.y.	1,260
9.	Aerators and controls (20 H.P.)	3 ea.	10,000	30,000
10.	Aerators and controls (5 H.P.)	2 ea.	6,000	12,000
11.	Fence	3,000 l.f.	5.00/l.f.	15,000
	COST OF CONSTRUCTION			$649,853
	10% CONTINGENCY			64,985
				$714,838
	ENGINEERING 7%			50,039
	Surveying & Staking 1.5%			10,723
	Inspection 3%			21,445
	Administration and Legal 1%			7,148
	TOTAL CONSTRUCTION COST:			$804,193
	USE:			804,000

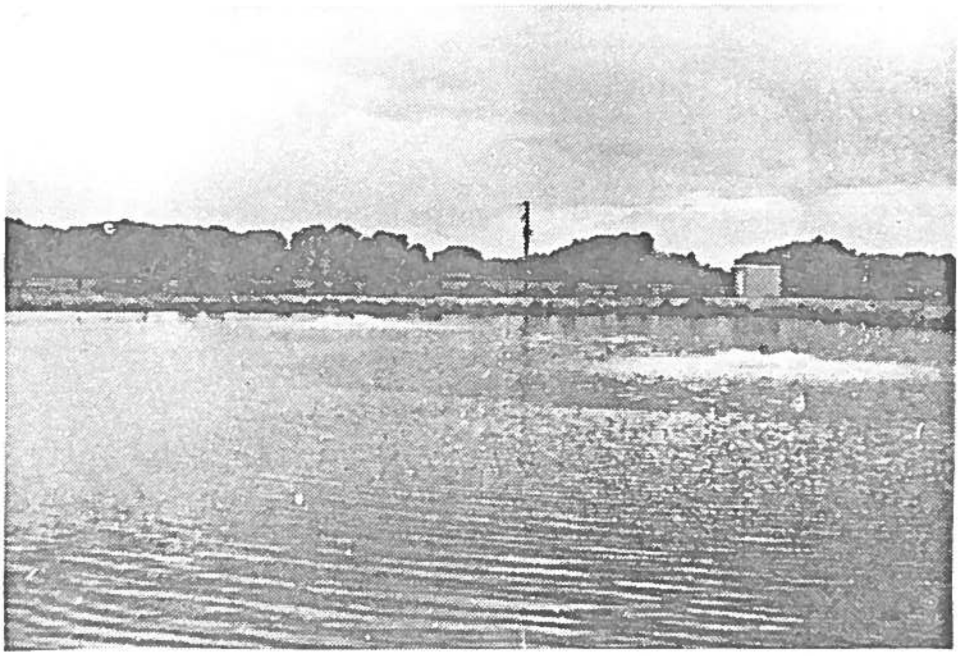


Fig. 5S-1

Southern Cell at Sewag[e] Lagoons- Two 5 H.P. Aerators in Foregroun[d] and Controls Building in Background

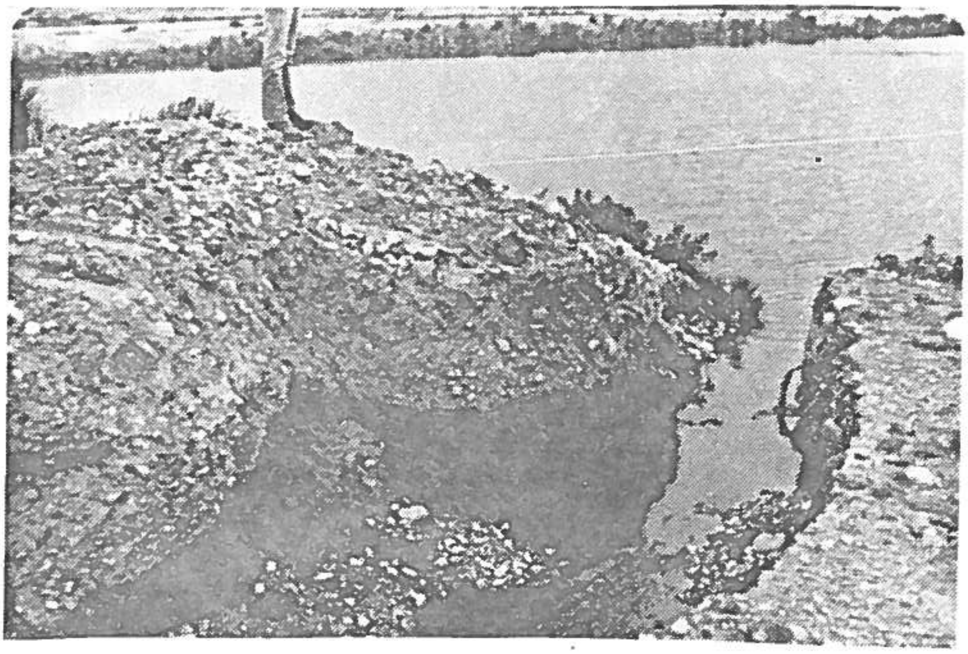


Fig. 5S-2

Temporary By-pass at Second Cell, Dug to Relieve Backup Problems in Town-1977

Fig. 5S-3

Lagoon Discharge Ditch Eventually Runs into River

Fig. 5S-4

Manhole on North End of Third St. Overflowing Due to Failure of Lift Station to Function

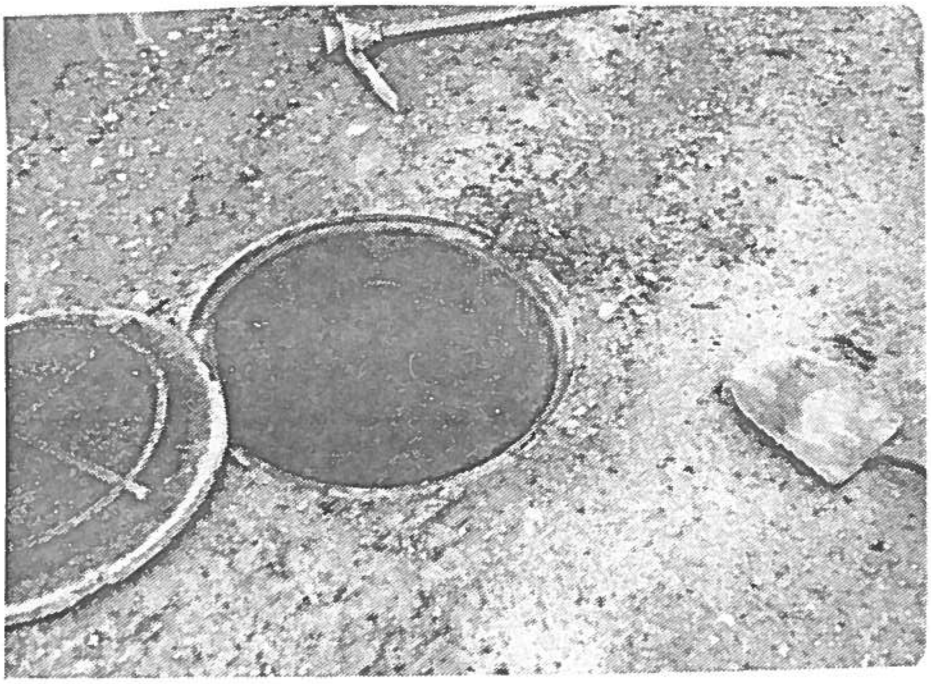


Fig. 5S-5

Manhole on Chatterton and E. Veterans St. Full Due to Undersized Lagoon Piping

Fig. 5S-6

A Typical "Lamp Hole" and Square Steel Cover Located on River St.

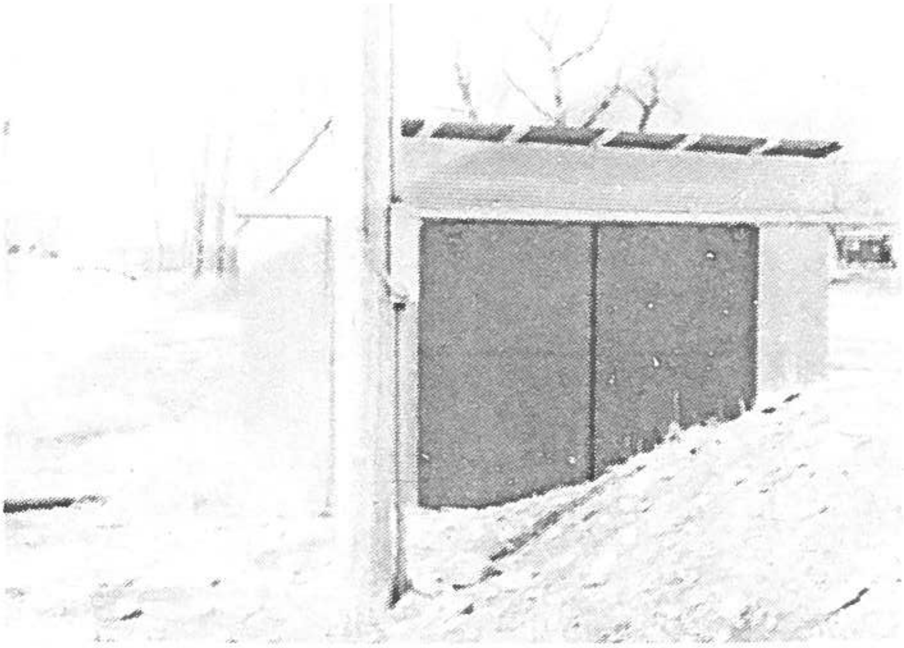
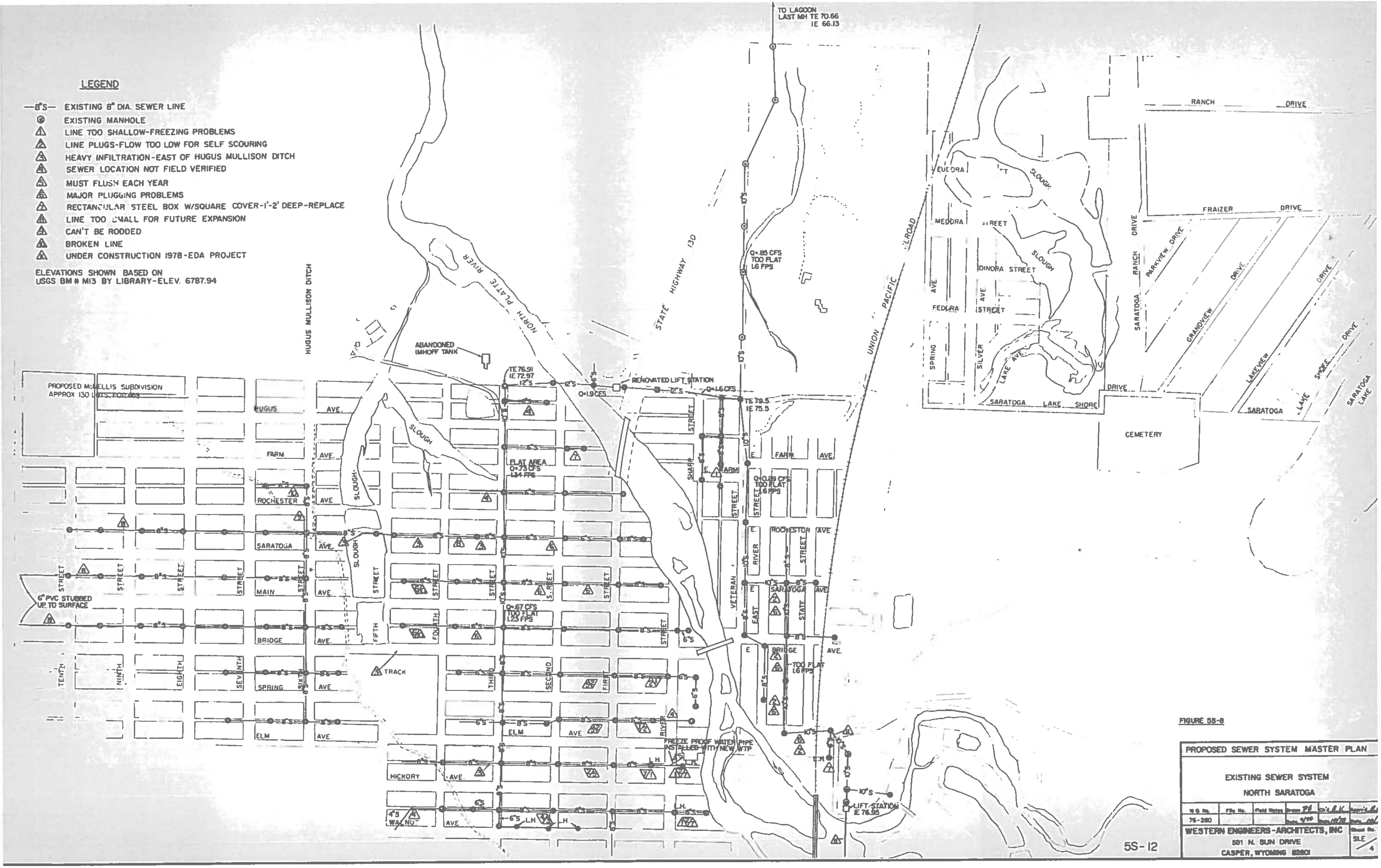
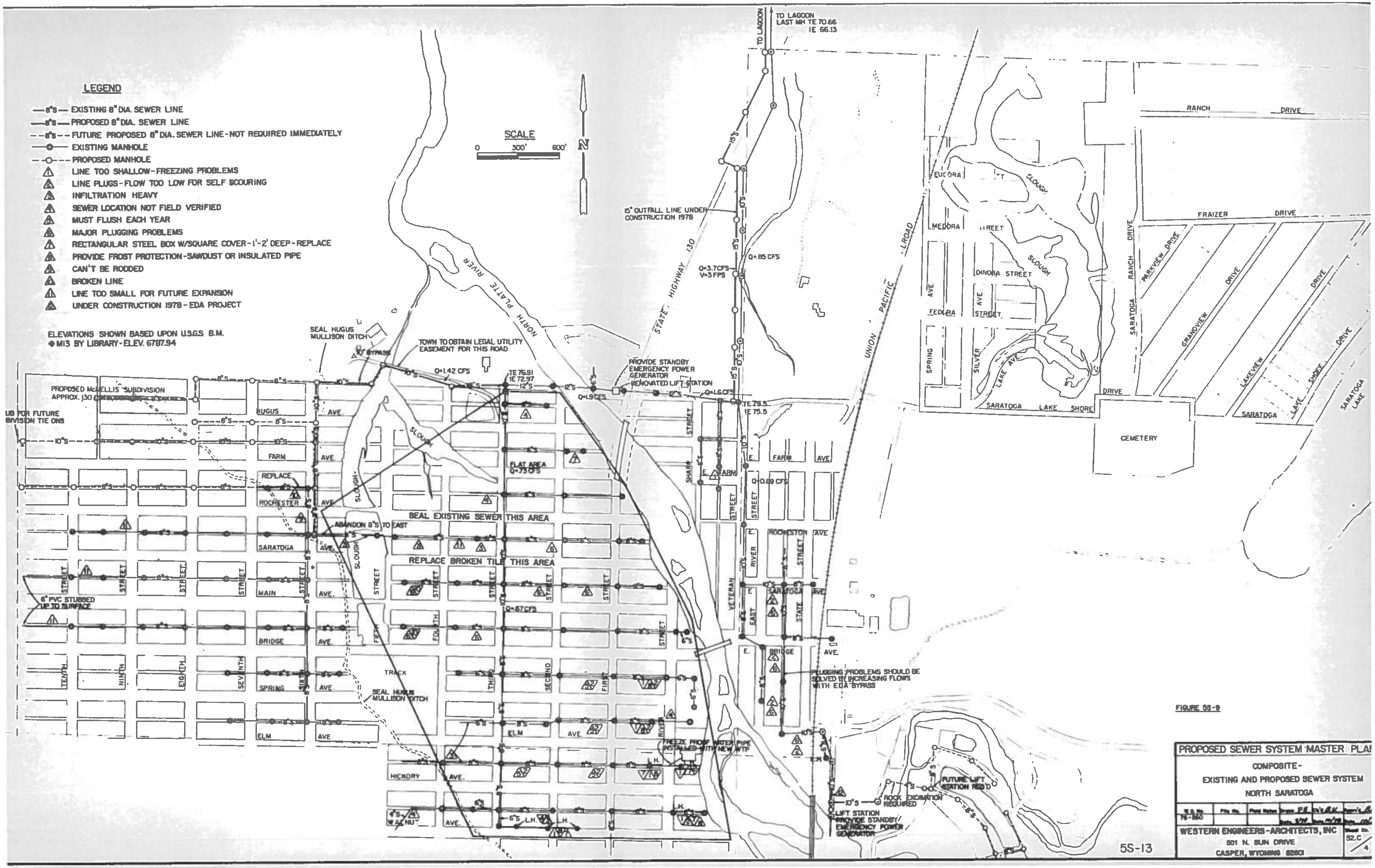
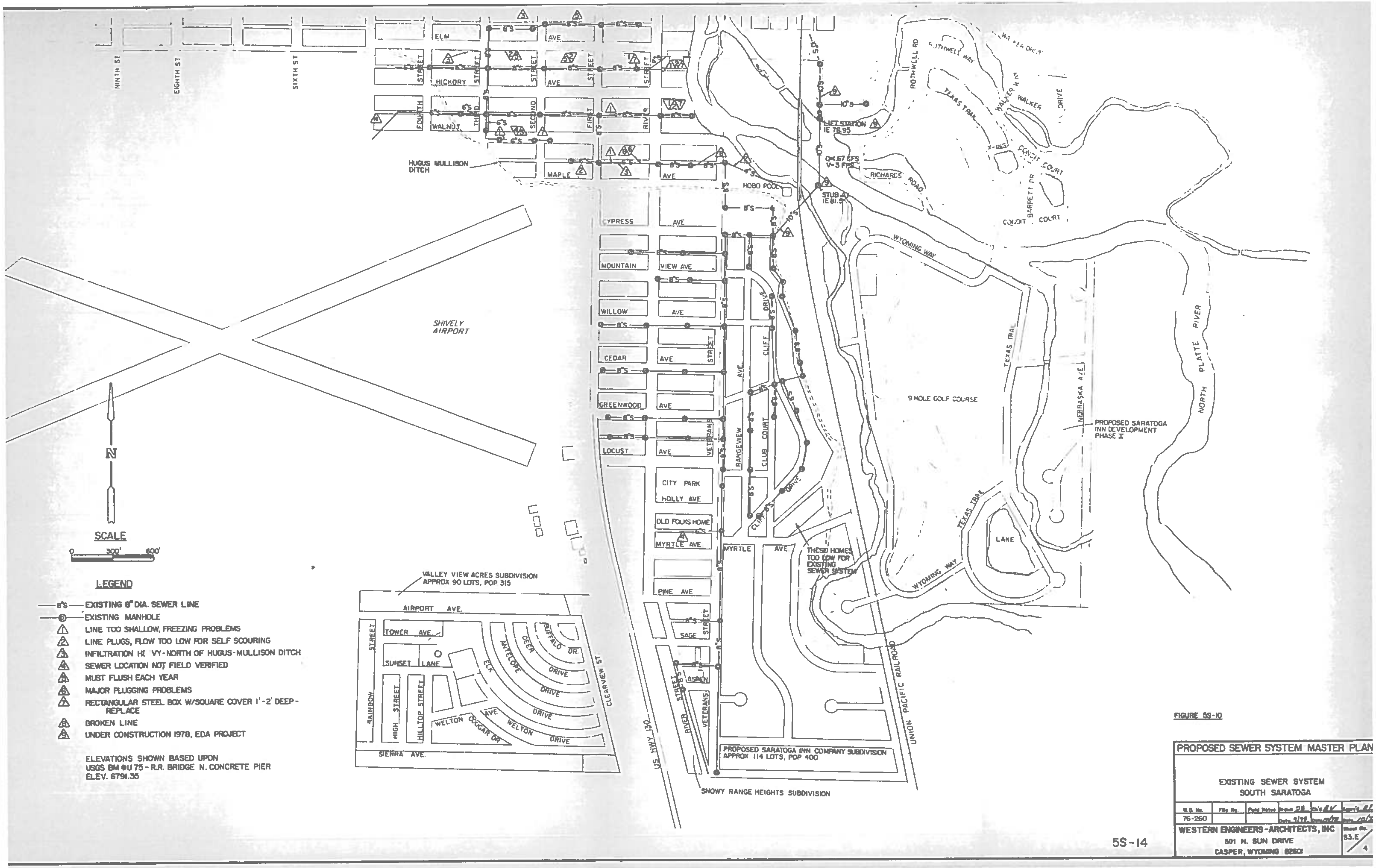


Fig. 5S-7

The existing Lift Station Building Prior to Renovation-1977


LEGEND
8"S — EXISTING 8" DIA. SEWER LINE
EXISTING MANHOLE
LINE TOO SHALLOW-FREEZING PROBLEMS
LINE PLUGS-FLOW TOO LOW FOR SELF SCOURING
HEAVY INFILTRATION-EAST OF HUGUS MULLISON DITCH
SEWER LOCATION NOT FIELD VERIFIED
MUST FLUSH EACH YEAR
MAJOR PLUGGING PROBLEMS
RECTANGULAR STEEL BOX W/SQUARE COVER-1'-2' DEEP-REPLACE
LINE TOO SMALL FOR FUTURE EXPANSION
CAN'T BE RODDED
BROKEN LINE
UNDER CONSTRUCTION 1978-EDA PROJECT
ELEVATIONS SHOWN BASED ON USGS BM # MI3 BY LIBRARY-ELEV. 6787.94
TO LAGOON LAST MH TE 70.66 IE 66.13
NORTH PLATTE RIVER
STATE HIGHWAY 130
UNION PACIFIC RAILROAD
HUGUS MULLISON DITCH
ABANDONED IMHOFF TANK
RENOVATED LIFT STATION
LIFT STATION IE 76.95
CEMETERY
FREEZE PROOF WATER PIPE INSTALLED WITH NEW WTP
PROPOSED McELLIS SUBDIVISION APPROX 130 LOTS
6" PVC STUBBED UP TO SURFACE
FIGURE 5S-8
PROPOSED SEWER SYSTEM MASTER PLAN
EXISTING SEWER SYSTEM
NORTH SARATOGA
76-260
WESTERN ENGINEERS-ARCHITECTS, INC
501 N. SUN DRIVE
CASPER, WYOMING 82601
SLE
4
5S-12


LEGEND
8"S EXISTING 8" DIA. SEWER LINE
8"S PROPOSED 8" DIA. SEWER LINE
8"S FUTURE PROPOSED 8" DIA. SEWER LINE-NOT REQUIRED IMMEDIATELY
EXISTING MANHOLE
PROPOSED MANHOLE
LINE TOO SHALLOW-FREEZING PROBLEMS
LINE PLUGS-FLOW TOO LOW FOR SELF SCOURING
INFILTRATION HEAVY
SEWER LOCATION NOT FIELD VERIFIED
MUST FLUSH EACH YEAR
MAJOR PLUGGING PROBLEMS
RECTANGULAR STEEL BOX W/SQUARE COVER-1'-2' DEEP-REPLACE
PROVIDE FROST PROTECTION-SAWDUST OR INSULATED PIPE
CAN'T BE RODDED
BROKEN LINE
LINE TOO SMALL FOR FUTURE EXPANSION
UNDER CONSTRUCTION 1978-EDA PROJECT
ELEVATIONS SHOWN BASED UPON U.S.G.S. B.M.
M13 BY LIBRARY-ELEV. 6787.94
SCALE
0 300' 600'
N
TO LAGOON
TO LAGOON LAST MH TE 70.66 IE 66.13
15" OUTFALL LINE UNDER CONSTRUCTION 1978
Q=3.7CFS V=3 FPS
Q=.85 CFS
PROVIDE STANDBY EMERGENCY POWER GENERATOR
RENOVATED LIFT STATION
Q=1.9 CFS
Q=1.6 CFS
TE 79.5 IE 75.5
TE 76.91 IE 72.97
Q=1.42 CFS
TOWN TO OBTAIN LEGAL UTILITY EASEMENT FOR THIS ROAD
SEAL HUGUS MULLISON DITCH
PROPOSED McELLIS SUBDIVISION APPROX. 130
UB FOR FUTURE DIVISION TIE ONS
FLAT AREA Q=.73 CFS
SEAL EXISTING SEWER THIS AREA
ABANDON 8"S TO EAST
REPLACE BROKEN TILE THIS AREA
Q=.67 CFS
Q=0.89 CFS
6" PVC STUBBED UP TO SURFACE
SEAL HUGUS MULLISON DITCH
PLUGGING PROBLEMS SHOULD BE SOLVED BY INCREASING FLOWS WITH EDA BYPASS
FREEZE PROOF WATER PIPE INSTALLED WITH NEW WTP
LIFT STATION PROVIDE STANDBY/ EMERGENCY POWER GENERATOR
ROCK EXCAVATION REQUIRED
FUTURE LIFT STATION REQ'D
NORTH PLATTE RIVER
STATE HIGHWAY 130
UNION PACIFIC RAILROAD
SLOUGH
CEMETERY
RANCH DRIVE
FRAIZER DRIVE
SARATOGA RANCH DRIVE
PARKVIEW DRIVE
GRANDVIEW DRIVE
LAKEVIEW DRIVE
LAKE SHORE DRIVE
SARATOGA LAKE
SARATOGA LAKE SHORE DRIVE
LAKE AVE.
EUDORA
MEDORA STREET
DINORA STREET
FEDORA STREET
SPRING AVE
SILVER AVE
HUGUS AVE
FARM AVE
REPLACE
ROCHESTER AVE
SARATOGA AVE
MAIN AVE
BRIDGE AVE
SPRING AVE
ELM AVE
HICKORY AVE.
WALNUT AVE.
TENTH STREET
NINTH STREET
EIGHTH STREET
SEVENTH STREET
SIXTH STREET
FIFTH STREET
FOURTH STREET
THIRD STREET
SECOND STREET
FIRST STREET
RIVER STREET
TRACK
SHARP STREET
E. FARM AVE
E. RIVER STREET
VETERAN STREET
ROCHESTON AVE
E. SARATOGA AVE
STATE STREET
EAST STREET
E. BRIDGE AVE
FIGURE 5S-9
PROPOSED SEWER SYSTEM MASTER PLAN
COMPOSITE-
EXISTING AND PROPOSED SEWER SYSTEM
NORTH SARATOGA
WESTERN ENGINEERS-ARCHITECTS, INC
501 N. SUN DRIVE
CASPER, WYOMING 82601
S2.C
4


PROPOSED SEWER SYSTEM MASTER PLAN
EXISTING SEWER SYSTEM
SOUTH SARATOGA
FIGURE 5S-10
76-260
WESTERN ENGINEERS-ARCHITECTS, INC
501 N. SUN DRIVE
CASPER, WYOMING 82601
S3.E
4
SCALE
0 300' 600'
N
LEGEND
8"S — EXISTING 8" DIA. SEWER LINE
EXISTING MANHOLE
LINE TOO SHALLOW, FREEZING PROBLEMS
LINE PLUGS, FLOW TOO LOW FOR SELF SCOURING
INFILTRATION H VY-NORTH OF HUGUS-MULLISON DITCH
SEWER LOCATION NOT FIELD VERIFIED
MUST FLUSH EACH YEAR
MAJOR PLUGGING PROBLEMS
RECTANGULAR STEEL BOX W/SQUARE COVER 1'-2' DEEP-REPLACE
BROKEN LINE
UNDER CONSTRUCTION 1978, EDA PROJECT
ELEVATIONS SHOWN BASED UPON
USGS BM #U 75 - R.R. BRIDGE N. CONCRETE PIER
ELEV. 6791.35
SHIVELY AIRPORT
VALLEY VIEW ACRES SUBDIVISION
APPROX 90 LOTS, POP 315
PROPOSED SARATOGA INN COMPANY SUBDIVISION
APPROX 114 LOTS, POP 400
SNOWY RANGE HEIGHTS SUBDIVISION
PROPOSED SARATOGA INN DEVELOPMENT PHASE II
THESE HOMES TOO LOW FOR EXISTING SEWER SYSTEM
9 HOLE GOLF COURSE
LAKE
NORTH PLATTE RIVER
UNION PACIFIC RAILROAD
US HWY 130
HUGUS MULLISON DITCH
HOBO POOL
LIFT STATION IE 76.95
Q=.67 CFS V=3 FPS
STUB AT IE 81.5
CITY PARK
OLD FOLKS HOME
NINTH ST
EIGHTH ST
SIXTH ST
ELM
HICKORY
WALNUT
MAPLE
CYPRESS AVE
MOUNTAIN VIEW AVE
WILLOW AVE
CEDAR AVE
GREENWOOD AVE
LOCUST AVE
HOLLY AVE
MYRTLE AVE
PINE AVE
RANGEVIEW AVE
CLIFF DRIVE
CLUB COURT
VETERANS
WYOMING WAY
TEXAS TRAIL
NEBRASKA AVE
RICHARDS ROAD
ROTHWELL RD
AIRPORT AVE.
TOWER AVE.
SUNSET LANE
BUFFALO DR.
DEER DRIVE
ANTELOPE DRIVE
ELK DRIVE
WELTON AVE
COUGAR DR.
HILLTOP STREET
HIGH STREET
RAINBOW STREET
SIERRA AVE.
CLEARVIEW ST

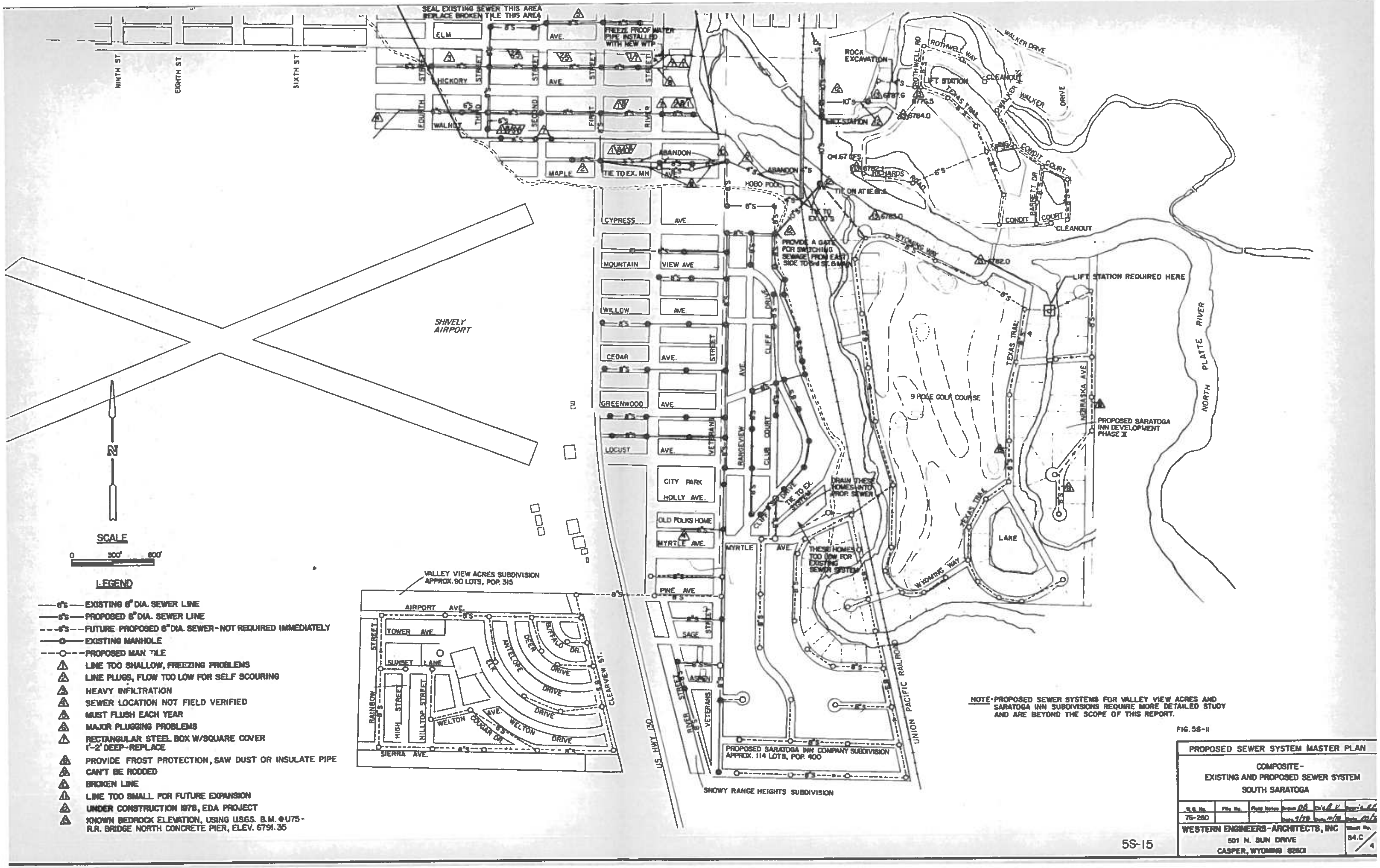


FIG. 5S-11

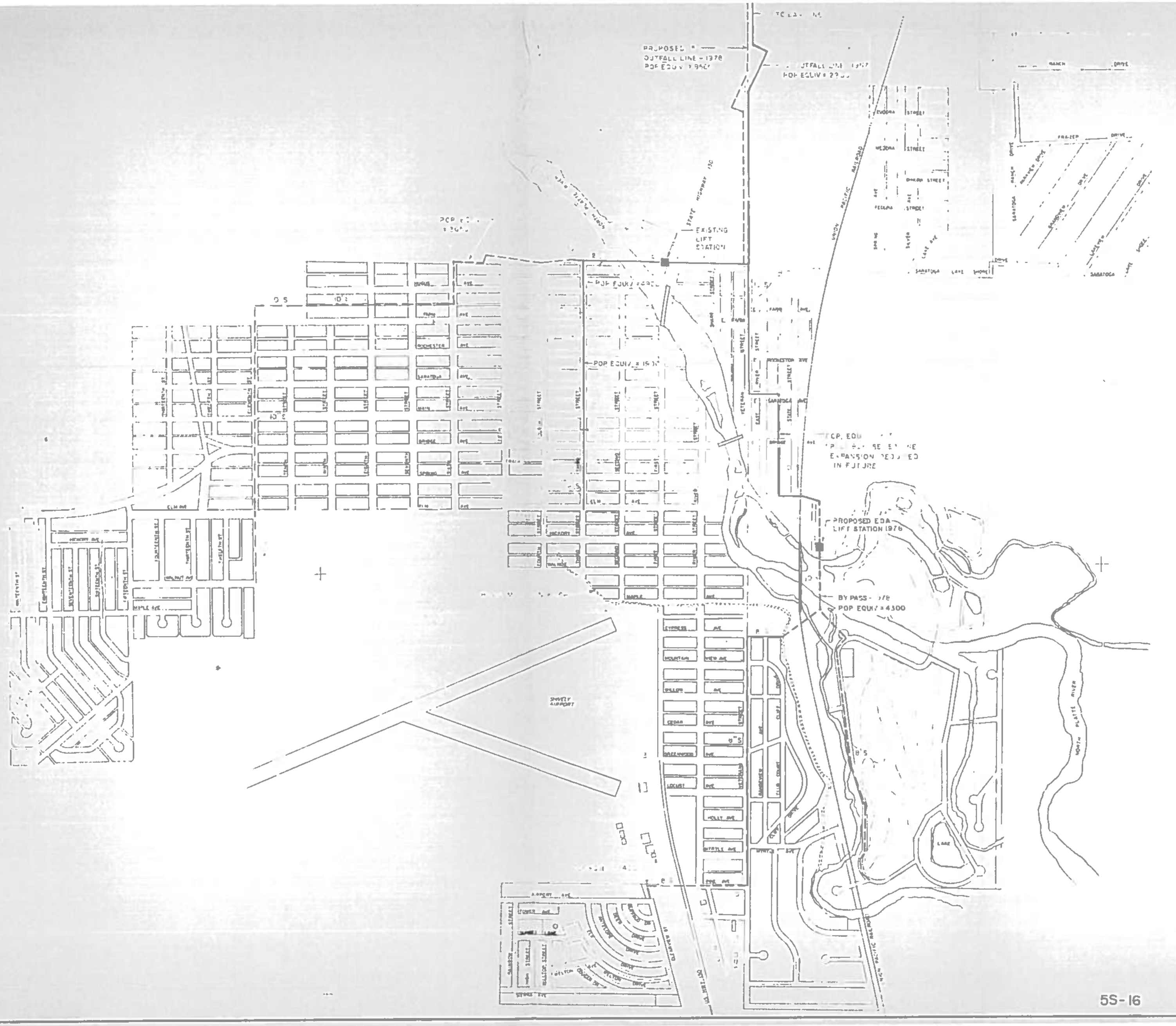
PROPOSED SEWER SYSTEM MASTER PLAN

COMPOSITE -
EXISTING AND PROPOSED SEWER SYSTEM
SOUTH SARATOGA

76-260

WESTERN ENGINEERS - ARCHITECTS, INC
501 N. SUN DRIVE
CASPER, WYOMING 82601

Sheet No. S4.C 4



LEGEND

—10"S— EXISTING 10" DIA SEWER MAIN
--10"S-- PROPOSED 10" DIA SEWER MAIN

NOTE POPULATION EQUIVALENTS BASED UPON PEAK HOURLY FLOW OF 250 G.P.C.P.D. CARRYING CAPACITY

Fig 5S-12

PROPOSED SEWER SYSTEM MASTER PLAN

MAJOR SEWER COLLECTOR LINES
AND
POPULATION EQUIVALENTS

W... ENGINEERS ARCHITECTS INC
801 N SUN DR
CASPER WYO 82601